

DOCUMENT-IDENTIFIER: US 5705685 A

TITLE: Conversion of alkanes to unsaturated carboxylic acids

BSPR:

The catalysts useful in the process of the present invention have the general formula  $H_{\cdot e} (X_{\cdot k} M_{\cdot m} M'_{\cdot n} O_{\cdot y})_{\cdot e}$  where X, the central

or hetero atom, is a Group IIIB, IVB, VB, VIB or **transition element, such as**

**phosphorus, silicon, gallium,** aluminum, arsenic, germanium, boron, cobalt,

cerium, praseodymium, uranium and thorium; M, the first framework metal is molybdenum, tungsten, vanadium or combinations thereof; M', the second framework metal, is different from M and is independently zinc or a transition metal, such as titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum, tungsten, manganese, rhenium, iron, cobalt, nickel,

ruthenium, rhodium, palladium, osmium, iridium, platinum, copper, zinc or combination thereof; k is 1 to 5; m is 5 to 17; n is 1 to 3; y is 18 to 59; and e is the charge of the anion of the heteropolyacid; or a polyoxoanion of such heteropolyacid. When n is 1, M' is other than molybdenum, tungsten or vanadium.

BSPR:

In one embodiment, the catalysts useful in the present invention have the general formula  $H_{\cdot e} (X_{\cdot k} M_{\cdot m} M'_{\cdot n} O_{\cdot y})_{\cdot e}$  where X, the

central or hetero atom, is a Group IIIB, IVB, VB, VIB or **transition element, such as phosphorus, silicon, gallium,** aluminum, arsenic, germanium, boron,

cobalt, cerium, praseodymium, uranium and thorium; M, the first framework metal

is molybdenum, tungsten, vanadium or combinations thereof; M', the second framework metal, is different from M and is independently zinc or a transition metal, such as titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum, tungsten, manganese, rhenium, iron, cobalt,

nickel,  
ruthenium, rhodium, palladium, osmium, iridium, platinum, copper, zinc or  
combination thereof; k is 1 to 5; m is 5 to 17; n is 1 to 3; y is 18 to 59; and  
e is the charge of the anion of the heteropolyacid; or a polyoxoanion of such  
heteropolyacid. When  $n=1$ , the second framework metal,  $M'$ , is other than  
molybdenum, tungsten or vanadium.